rounded by a fine proteid membrane. This membrane is impermeable to lecithin.

During the exchange of water for chloroform a characteristic structure appears in the droplet. It is at first clear but within 30 seconds becomes filled with a dense mass of granules (probably water) so that it looks white against a dark background. The droplet is still mostly chloroform, as may be determined by pricking it with a needle. The contents do not mix with the water.

In the course of an hour, the dense granular structure disappears and the drop clears. There remain only a few dense granules (probably some form of lecithin) mostly aggregated together to form an excentric knot like a karyosome. It is in this stage, which is stable and persists until destroyed by bacteria, that the resemblances to sea urchin eggs are most marked.

If pricked with a needle the contents flow slowly out as a viscid protoplasm-like mass and mix (except the granules) with the water. No chloroform is now present.

The cells are not rigidly spherical in shape, as oil globules suspended in water, but present exactly those slight irregularities which may be observed in freshly laid sea urchin eggs.

The surface film is similar to the surface membrane of a sea urchin egg in appearance and also in consistency, as indicated by its resistance to pricking and to pressure.

Neutral red is accumulated from dilute solution by the cell as a whole but in particular by the granules, which stain very deeply.

Such red stained cells are turned yellow at the same rate by $n/2,000$ NaOH and $n/2,000$ NH_4OH. In regard to their permeability relations they therefore differ markedly from marine eggs, which are entered much more rapidly by NH_4OH. They possess also no polarity except one attributable to gravity.

These artificial lecithin cells resemble egg cells in one more important and striking respect. If a trace of saponin is added to the sea water in which sea urchin eggs lie, the eggs almost instantly swell and the contents become more fluid and clear, *i. e.,* the eggs cytolyze. Exactly the same thing happens when a trace of saponin is added to water containing lecithin cells. They swell and become clear spheres with only a few granules in the interior. The similarity is indeed perfect.

Future work may indicate methods by which protein can be obtained within a lecithin membrane, the whole of a size comparable with cell size, or can be introduced into lecithin cells. Such cells promise to exhibit even more striking and interesting properties than those herein described.

E. NEWTON HARVEY
WOODS HOLE, MASS.,
September 6, 1912

A METHOD OF DETERMINING THE AVERAGE LENGTH OF LIFE OF FARM EQUIPMENT

IN determining the cost of farm operations one of the most difficult items to determine accurately is the rate of depreciation of farm equipment. Recently Mr. H. H. Mowry, of the Office of Farm Management, who has collected extensive data on the problem of depreciation of farm equipment, suggested to the writer the possibility of determining the average length of life of a farm implement from data relating to the number of years each implement has been used. Apparently a solution for this problem has been found. The solution applies to all objects, either animate or inanimate, lasting for varying lengths of time.

Two cases are to be considered, namely, (1) when the number of the objects under consideration is approximately constant from year to year, and (2) when their number is increasing or decreasing. The first case may be conveniently considered in its application to farm dwellings. Suppose that on a given group of farms there is a definite number of farm dwellings of various ages, and that as fast as old dwellings become unsuited to their purpose they are replaced by new ones. For convenience of reference let us reduce the numbers with which we have to deal to symbols. Let N_1 represent the number of dwellings in their first year of life, N_2 the number in their second year, N_3 the number in their third year, and so on, N_n representing the

number of dwellings of the oldest age represented in the group.

In any group of objects which last for varying lengths of time but in which the number of objects is kept constant by replacing discarded ones by new ones the following principles apply:

1. The number of old objects discarded each year is, on the average, equal to the number of new ones introduced.

2. The average number of objects in the second year of their life at a given time is equal to the average number of those in their first year that will live to enter their second year. The average number in their third year is on the average equal to the number of those in their first year that will live to enter their third year, and so on. In general, the number of objects in their nth year is equal to the number of those in their first year that will live to enter their nth year.

3. Hence N_2, N_3, etc., which represent the number of objects now in their second, third, etc., years of life, may also be taken to represent the number of the objects now in their first year that will ultimately reach their second, third, etc., years of life.

4. If now we add together N_1, N_2, N_3, etc., this is equivalent to counting each object now in its first year as many times as it will live years. Hence the sum of N_1, N_2, N_3, etc., which represents the total number of objects of all ages, also represents the sum of the ages that will be attained by all the objects now in their first year.

5. Therefore, if we divide the total number of objects of all ages in the group by the average number in their first year the quotient will be the average length of life that those now in their first year will live. But since the average number of objects in their first year is the same from year to year, this average is a general one and applies to the whole population. We may thus express the average length of life of any constant population by means of the following formula:

$$L = \frac{N_1 + N_2 + N_3 + \cdots + N_n}{N_1}. \qquad (A)$$

This formula may be expressed more simply by writing for the numerator simply the total population instead of the sum of individuals of different ages. We thus have

$$L = \frac{P}{N_1}. \qquad (B)$$

In this formula L equals the average length of life, P the total population, and N_1 the average number in their first year of life at a given time.

In applying either of the above formulæ to cases like those of farm houses and most kinds of farm implements the fact that very few such objects are discarded until they are at least four or five years old makes N_1, N_2, N_3, N_4 and N_5 approximately equal. That is, the number of objects one year old is about the same as the number two years old, or three years, etc., up to about five years, and sometimes even longer. In making a study of such objects with a view to determining the average length of their life it is usually possible to get quite accurately the number of objects in the group in each year of life up to five or six years of age, and where these numbers are about the same for each year their averages will represent quite accurately the average number of new objects introduced in a year, which is the same as the average number of old ones discarded. Hence, in populations where the number of objects in each of the earlier years of life is approximately the same, the average length of life in the population may be obtained by dividing the total number of objects by the average number in each of the early years of life.

POPULATIONS THAT ARE DECREASING OR INCREASING

The principles stated above do not apply in a population that does not remain constant from year to year. It is not difficult, however, to work out a formula based on formula (A) above that does apply to such populations. This may be done as follows:

Suppose the rate of increase in population is 1 per cent. a year. Then if P represents the population in any one year, $1.01P$ will repre-